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Engine with Rotary and Reactive Chambers
[Moteur à chambers rotatives et réactives]

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/1[1]

The present invention relates to “rotary”-type internal combustion engines, supplied by a carburetor and used in fields currently reserved for conventional piston engines, specifically automobiles.

Rotary engines currently in use or being developed through experiments are generally made up of a specially-shaped rotor that, moving inside a stator, creates the four cycle times through volume variation, with intake and exhaust being carried out with or without a valve.

The technological simplicity of these engines, which is more apparent than real, is very seductive; however, problems involving sealing, cooling, heat concentration and stress, and the maintenance of constitutive parts has resulted in their development being a long and difficult process, since their yield never achieves that of the conventional piston engine, thereby leading to high specific fuel consumption. Their longevity is another point of inferiority. Lastly, the energy contained in the exhaust gases, namely 43% of the total energy provided by the fuel, is – as in their piston-driven precursors – totally lost.

The engine of the present invention aims to recover a major portion of the kinetic and temperature energies contained in exhaust

[1] Numbers in the margin indicate pagination in the foreign text.

gases. This ability, along with the engine’s inherent qualities, makes progress towards a high overall yield that takes the form of a noteworthy decrease in specific fuel consumption.

Principle of the engine, FIG. 1.

A rotor with three fixed vanes set at 120 degrees is equipped with three intake valves. It moves inside a rotor equipped with three sealing valves, three spark plugs, and three exhaust valves and nozzles. This assembly forms three independent chambers.

The two rotors turn at the same angular velocity; their “excentric” position conditions, for each chamber, the volume variations inherent to the four cycle times.

The carbureted air arrives at the center of the inner rotor, is allowed into the relevant chambers, compressed, expanded to the engine time, and expelled by the exhaust openings and nozzles. This tangential ejection enables direct recovery of the kinetic energy of the gases. A water injection at the beginning of exhaust and above the valve is an optional complement to this action.

Brief description of the engine, FIG. 1 AND 2.

An inner rotor 1 centered on 0 (XY axis) moves inside an outer rotor 2 centered on 0’ (X’Y’ axis). Note: 00’ = d. These two rotors are connected by three tie rods 16 set at 120 degrees.

A crankcase having two main parts 9 and 10 supports the roller bearings and ball bearings needed for the rotation of the mobile assembly. At its top, it is equipped with a filler door 11 that has a

“high voltage” sector 12. The bottom of the crankcase, which opens broadly, houses the exhaust manifold 13.

/2

An accessory hood 14 – FIG. 2 and 3 – ensures, via adapted gears, the control of supply, distribution, and ignition parts.

A drive flywheel 15 with a starter ring – FIG. 22 – is equipped with blades 17 in order to ventilate the engine.

Technical characteristics:

The minimal play separating the two rotors at their closest point (PMH), FIG. 8, is equal to 1/400 of the inner diameter of the outer rotor.

The ratio of the diameters of the two rotors is 17/20, which corresponds to a volumetric ratio close to 9, taking into account the various additional volumes (openings of valves, slides, etc.).

These two characteristics determine “d” (00’), the distance separating the rotor rotation axes XY and X’Y’ and the axes of each conjugation tie rod 16.

Since the two rotors have, given the presence of the abovementioned tie rods, an absolutely equal angular velocity, the displacement of the vanes is always perpendicular to the plane of the sealing valves, whose movement remains perfectly straight.

The rotation speed of the intake and exhaust cams is equal to ¾ that of the rotors. Their rotation direction in relation to the valve

levers and tappets is consequently the opposite of the engine’s rotation direction.

The ratio of the timing gear is defined as follows:

AC/BD = 3/4 AC’/B’D’ = 3/4

The distribution measurements – FIG. 6 – are as follows:

Intake opening advance: 15 degrees

Intake closing delay: 30 degrees

Exhaust opening advance: 30 degrees

Exhaust closing delay: 0 degrees

In light of these provisions, and of the shape of the valve lever and tappet collars, the length of the cams is that shown in FIGS. 14 and 18.

Ignition: With an explosion occurring every 240 degrees – FIG. 7 –-, and with the chambers being numbered clockwise whereas the engine’s rotation direction is counterclockwise, the ignition order is 1-3-2.

The ignition advance varies from 10 to 30 degrees.

The spark plugs – FIG. 13 – are of the “protected electrode” type. They are reinforced by a steel cone-shaped sleeve that extends, at its upper part, the hexagon whose braking system must have a cover (indicated in dashed lines in the figure) held by two hexagonal-head screws onto the support rotor.

The chamber mounting of a second spark plug requires that it be supplied by a second high-voltage sector.

The rotation speed of the contact breaker 18 - FIG. 3 - is, for a three-lobed cam, equal to the half speed of the engine.

Embodiment details

Sealing of chambers - Slides and segmentation.

Slides: Displacement of the vanes 3 as they pass through the outer rotor occurs inside a rectangular opening, blocked by slides 5 made of treated aluminum alloy. The "sliding" contact of their shoe on the flat surface 19 of the outer rotor is ensured by two straight tracks 20, each of which has, as a lower race, a lamella made of tempered steel 21 - Fig. 1 - fixed along the edge of the slide, and, as an upper race, an undercut 22 made three times at 120 degrees into each flange 23 and 24, FIG. 20. Bearings or rollers ensure functioning. Final sealing is, as was the case for the vanes and the inner rotor, realized by appropriate segmentation.

Segmentation: This is carried out via double cast iron segments 25. As they are not very thick, they are housed inside grooves 26 measuring 2 to 3 mm wide and are kept pressed against the opposite wall by corrugated steel lammellae 27 placed at the innermost part of the groove. Figure 4 shows the shape and arrangement of the vane segments and their connection to each circular rotor segment, underneath which is located the circular scraper segment equipped with a notch that is provided to accommodate an immobilization pin. Figure 5 shows in detail the "subslide" segmentation. Note: the

longitudinal groove is located at only 1 m from the edge of the chamber.

Intake. FIG. 2-8-12-14-15.

FIG. 8 shows the anticipated location of the valve.

Provided by a carburetor 28 that is integrated into the accessory hood by hexagonal screws while a joint 29 made of plastic material ensures sealing with the rotating intake tube 30, the carbureted air and additional lubricating oil arrive at the center of the inner rotor in order to be brought into the rotary chambers when the intake valves 4 are opened.

Intake valves 4 FIG 8. Each of these is included in an assembly that includes a guide bracket 34 and a tubular valve 32. The guide bracket, made of tempered steel, has a threaded outer lower section so that it can be screwed, then clamped (33) into the peripheral body of the inner rotor 1. Its upper section FIG. 8 and 12 is made up of a seat at 45 degrees connected to the body by six arms 35. A cone 36 made of aluminum alloy, crimped at its lower section, allows carbureted air to flow through. The valve 32 slides into a ring 37 that is screwed into the lower part of the guide bracket and is equipped with a double seal, made of cast iron. It has two reinforcements for housing the shaft 40 of the control bearing 41. The latter is connected to the intake valve lever FIG. 1, which moves on the two-lobed cam 42.

/4

Intake valve levers 43 FIG. 2. Each valve lever has its left cylindrical face free inside a ring 44. Its right face oscillates inside a blind ring 45 which houses one of the ends of the return spring 46. By turning the heel of the ring in the desired direction, then positioning the key provided for this purpose, the spring is tensioned.

The dynamic equilibrium of the valve lever/connecting rod/valve system is designed so that the action of centrifugal force remains, within allowed limits, predominantly on the valve side.

Two-lobed intake cam 42 FIG. 14. It is machined at the right end of the intake tube (FIG. 2). The latter, in rotation inside the bearing 83 and the ring 47 made of pink metal housed at the outlet of the inner rotor's hollow pin 48, is driven by the gear D integrated into it by a grooved shank. The gear D, via A, B, C, is connected to the rotor 1.

Exhaust FIG. 1-2-8-9-10-11-16-18.

Note: Even though the solution of figures 1 and 2 makes it possible to better diagram certain details, the solution of the following figures, considered more technically advantageous, is the only one retained.

Exhaust flows through the opening of a valve 7 made of special steel. The latter has an anti-heat skirt 49, which slides into a guide 50, made of bronze, protected by a stainless steel ring 51. The valve is caused to return to its seat by a “safety-pin”-type spring

52 FIG. 9 that completes, at low engine speed, the action of centrifugal force.

As was the case for the “intake” valve lever system, the system for controlling the exhaust valves is dynamically equilibrated such that the action of centrifugal force remains, within allowed limits, predominantly on the valve side.

Each exhaust valve lever 53 FIG. 9 oscillates inside a support that, crossing the left flange, is adjusted and screwed onto the outer rotor. The arm of the valve lever in contact with the valve stem has FIG. 11, at its starting point, the shaft 54 of the tie rod 55 that controls the piston 56 that fills the valve cooling channel. The arm, on the valve lever rod side, is equipped at its end with a clearance compensation system 57 FIG. 9 that is accessible via a hole 58 FIG. 2, made in the engine crankcase. The rod 59 receives its movement from a tappet FIG. 18 that may be separate from 60, or integrated into 61, the water injection system. Each tappet, whose housing is provided at every 120 degrees in the neck of the left flange 108 FIG. 16, is actuated by a two-lobed exhaust cam 63, machined onto the hollow pin of the gear D’. The latter is positioned inside the neck of the left flange by two roller and ball bearings 110 and 111.

The gear D’, via A, B’, C’, is connected to the engine rotor 1.

Exhaust nozzles FIG. 8 and 10. Made of high-temperature steel, each nozzle 8, convergent in the width direction, has two reinforcing

ribs at its outer upper part. It is kept in place inside a cone-shaped housing by being held between the upper spring-holding strut 64 and the “adapted” body of the outer rotor 2 (left part 107).

/5

Exhaust manifold 13 FIG. 1-2-22. Made of heat-resistant steel, it is U-shaped (FIG. 2); the height of both sides of the U increases in the engine rotation direction. After following the exhaust over 180 degrees, it ends at a large-diameter outlet tube 65. Equipped with directional vanes 66 that facilitate evacuation of the gases, it is attached to the case by malleable feet 67 held by spacers 68.

Water injection FIG. 17-18.

Figure 18 shows, at 60 degrees from each other, an exhaust tappet 60 and an injection valve lever 69. In this case, injection involves the exhaust controlled by the opposite cam. Therefore, it is more rational to group the two systems as follows FIG. 18: The cam in question engages a roller 70 mounted on a tappet whose summit housing receives the semicylindrical guide collar 71 of the injection valve lever 69. Above the collar and indicated in dashed lines 61, is the exhaust rod holder cup. Centered on 72, the valve lever, brought back by the spring 73, engages the piston 74 of the injection pump.

Injection pump FIG. 18: Water intake occurs in the upper part of the cylinder, under the piston 74, penetration of which results in expulsion towards the injector, which discharges above and in front of each exhaust valve.

Operation of the device in figure 18: Injection takes place when the engine speeds, and consequently the centrifugal force, ensure the return of the piston. In the device in figure 17, where the piston has a return spring, injection only occurs once the centrifugal force of the weight 75 applied onto the check valve 76 maintains, inside the injection circuit, a pressure above the injector's setpoint: 30 Kg/cm2.

Pump supply circuit (not shown in the figures).

It is designed as follows: Water tank – Pump identical to that of the fuel circuit – water supply channel crossing the carburetor support and following rotation axis XY up to a swivel connector located at the entrance to the right flange 78 of the inner rotor – One channel directs the water towards the ring-shaped spacer 78 and the left flank, connected in tubular fashion by a Z-shaped connector at right angles to the opposite wall of the outer rotor, where a ring-shaped space collects the water to distribute it to the pumps.

Remark: As was the case for the tie rods 16, the distance between the axes of the connector (parallel branches of the Z) must be equal to "d" (00'). For a rotor, the distance – axis of swivel joint, rotator rotation axis – is equal to that separating the same axes on the other rotor.

/6

Lubrication: The oil is contained inside a tank 79 or a case placed under the engine; it is pumped by a gear pump 80 towards

injection nozzles located at the meshing point of the distribution and accessory drive gears. It is recovered at 81, the lowest point of the lubricated case. Inside a space marked off by special sealing joints 82, an oily mist develops, which envelops the various bearings, cams, and exhaust tappets, reaching the valve lever rod ball joints by internal circulation and centrifugal force. The valve lever shafts are lubricated by the oil, which, bled above the outer rotor bearing 86, is emptied out via centrifugation through a radial channel towards the shafts. A bypass goes up to the valve guides and pistons for sealing the cooling channels. The rotor bearings 87 and 88 on the output shaft side are lubricated by gravity from a small, constant-level "overflow" tank that returns the oil to the case, supplied at a reduced flow rate by the pump. The shafts of the tie rods 16 are lubricated by the mist developed by lubrication of the right outer rotor bearing. Lubrication of the intake system (cam/valve levers/valves) of the chamber walls, including the vanes and slides, is carried out by a traditional distributor device, connected to the gas control and causing oil to arrive on the gas pump, where a careful mixture is made.

Cooling FIG. 2: Cooling is carried out by forced ventilation that includes either an incorporated fan FIG. 2, or a separate fan (not shown). In the example presented in FIG. 2, blades made of lightweight alloy, integrated into the engine flywheel, via directing vanes integrated into the case 10, direct a current of fresh air

towards the blades 90 of the outer rotor, and around the output shaft 92 where, via a ring-shaped conduit 93 and three oblique ducts 94 FIG. 2 and 19, it is introduced into the inner ring-shaped space 95 of the rotor 1, to be emptied out by the hollow vanes 3. Six air scoops 96 distributed inside the volute of the fan, lead out, via external conduits, to a detachable ring-shaped chamber 97 that is interrupted at one point by the intermediary gear shaft support 98. The air used for cooling the exhaust valves FIG. 11 is collected at its outlet from the ring-shaped chamber, for each valve, by a cup 99 (indicated in dashed lines in FIG. 2) that is 30 degrees long, directly supplying the intake system that gives out onto the rear of the valve via a channel having an adequate diameter 100 FIG. 11. Total evacuation of the cooling air is carried out by the exhaust manifolds and conduits.

Accessory hood: It accommodates FIG. 2, the carburetor 28, holds the distribution gears A, B, C, D, B′ and FIG. 3, controlled by A, the gear A′ that is integrated into the horizontal shaft bearing the alternator drive pulley 103 drives the vertical shaft with its oil pump 80, its gas pump cam 101, its tappet 102, and its contact breaker holder 18.

Inner rotor FIG. 19. It is made up of two parts assembled by screws. The first part is made up of the drum 104 that holds, set at 120 degrees, the hollow vanes 3, the intake valves 4, the left intake valve lever shaft rings 44, and receives, in concentric fashion, the

ring-shaped spacer 78 that separates the intake/cooling zones. It is extended outwards on its left by the hollow pin 48 supported by the case bearings 84, 85, and equipped with the gear A.

The second part includes the right flange 77 that bears, set at 120 degrees, the blind rings 45 of the valve lever shaft (right side) and the rings for tensioning the return spring 46. It is extended outwards on its right by the output shaft 92 equipped with the tie rod bracket flywheel 105. A ring-shaped conduit 93 directs the cooling air evacuated by the hollow blades towards three oblique conduits 94 and the subperiphery of the rotor.

Outer rotor FIG. 20. It includes four parts assemble with screws: the left body 107, the left flange 23, the right body 113, and the right flange 24.

The left body carries, set at 120 degrees, the valve levers 53, the valves 7, and the exhaust nozzles 8; the left body receives the large-diameter ball bearing 86 FIG. 2, the left flange 23 with its centering groove 112, its neck 108 equipped with exhaust cam bearings 110 and 111 and with three tappet housings. Cooling blades 91 and three undercuts 22 making up the left straight upper slide valve track complete the assembly.

The right body carries, set at 120 degrees, the spark plugs 6, receives the right flange 24 with its centering groove 114, its cooling blades 90, its large-diameter ball bearing 87, and its three

conjugation tie rod dual bearings 16. Three undercuts 22 make up the right straight upper slide valve track.

Once assembled, the left and right bodies have, at 120 degrees, three flat surfaces 19, at the center of which is located the rectangular opening through which the vanes pass. The opening is bordered by a double ring, on which the relevant sealing valve rests and slides.

Bi-rotor engine with vanes offset at 60 degrees.

Coupling of two single engines may be carried out according to the diagram in Figure 21, characterized in that it details the following parts:

Intake tube with two dual cams and two carbureted air outlets 117. Dual inner rotor 118 that drives, by intermediary gears 119, the intake cam holder tube 117. Central gear 120, located inside the ring gear 121 that supports the exhaust cams 63 on the outside. Exhaust valve levers 53, dual outer rotor 122, spark plugs 6, conjugation tie rods 16, transmission output shaft 92, exhaust manifold 13.

/8

General appearance of the monorotor.

Figure 22 shows the following elements: Left part 9 of the main case, right part 10, upper filler door 11 with its high-voltage inlet. Exhaust manifold 13, case spacers 68, accessory hood 14, carburetor 28, oil tank 79, ventilation air intake 124, drive flywheel 15 and starter ring, starter slot 125.

Technical and thermodynamic qualities of the rotary-chamber engine:

Excellent filling of chambers, in the direction of centrifugal force.

Internal sealing is easily carried out and maintained, no segments with sharp tops.

Motor effect is on the inner rotor, therefore on the output shaft.

Direct use of propulsive energy from the exhaust gases, hence the device is simple and has a high yield. No back pressure.

Option of recovering part of the temperature energy by injecting water when exhaust begins.

Homogeneity of cooling:

The inner rotor is continuously swept over by the air that empties out through the hollow vanes, in the direction of centrifugal force.

Outer rotor is cooled by the ventilation air that empties out through the exhaust manifold.

The chamber walls are subject to the four cycle times.

The exhaust valves, once closed, are swept over by the fresh air emptied out by the nozzle.

It should be noted that the various constitutive parts, made with current machining techniques and with normal tolerances, are inexpensive to manufacture.

Regarding issues of operational safety and longevity, the following should be noted: In the example with the dimensions shown in figures 1 and 2, the inner rotor/outer rotor relative speed does not exceed 6 m/sec. at 6000 rpm, whereas the assembly of the parts in contact with each other operates under optimal temperature and lubrication conditions.

To summarize, the invention – thanks to its reliability, yield, and lower fuel consumption – may be used in all fields usually reserved for conventional piston engines.

/9

CLAIMS

1. "Internal combustion" engine with rotary and reactive chambers, characterized in that it includes:

1.1. Three variable-volume chambers obtained by combining two excentric rotors having equal angular velocities. The first, equipped with three hollow vanes set at 120 degrees, moves inside the second, whose peripheral surface area, equipped with a special sealing system, allows the vanes to pass through to the outside.

1.2. A special intake device.

1.3. A device for ventilating the inner rotor.

1.4. A system for cooling the exhaust valves.

1.5. A means for recovering the kinetic energy from combustion gases.

1.6. A means for recovering part of the temperature energy from these same gases.

1.7. The option of grouping two monorotors together.

2. Device according to Claim 1.1, characterized in that the sealing system is, for each vane, made up of a slide valve that is kept in place and guided on the flat surface of the outer rotor by two straight tracks that rest on the left and right flanges.

3. Device according to Claim 2, characterized in that the straight displacement of the valves is obtained by subjecting the inner and outer rotors to the same angular velocity by means of tie rods that ensure their mechanical linkage.

4. Device according to Claim 1.2, characterized in that the intake system includes, arranged inside the inner rotor wherein the carbureted air arrives, three tubular valves and their controls.

5. Device according to Claim 1.3, characterized in that cooling of the inner rotor is carried out by the ventilation air taken in at its subperiphery and evacuated by the hollow vanes.

6. Device according to Claim 1.4, characterized in that the exhaust system includes three valves that are cooled by the ventilation air taken in when the exhaust is closed by the withdrawal of a blocking piston.

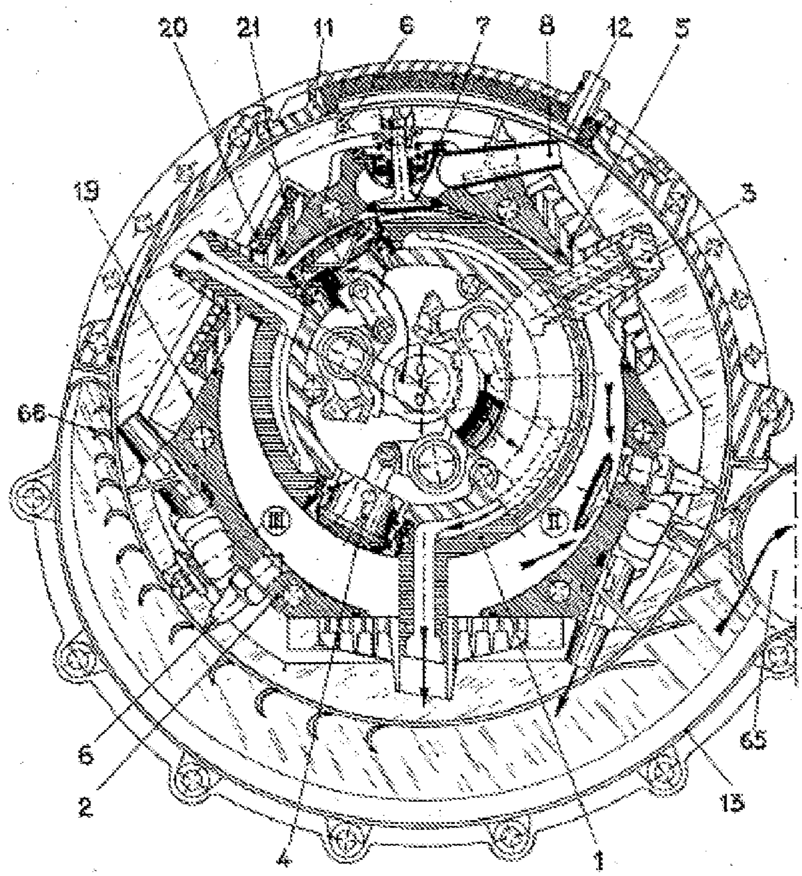
7. Device according to Claim 1.5, characterized in that the means for recovery kinetic energy from the gases is made up of three ejection nozzles arranged on the periphery of the outer rotor.

8. Device according to Claim 1.6, characterized in that the means for recovering part of the temperature energy from the gases is made up of a system for injecting water above each exhaust valve as it begins to open.

9. Device according to Claim 1.7, characterized by the option of grouping together two monorotors in order to obtain a double swept volume and with rotor vanes offset by 60 degrees, three engine cycles per revolution.

[FIG.1]

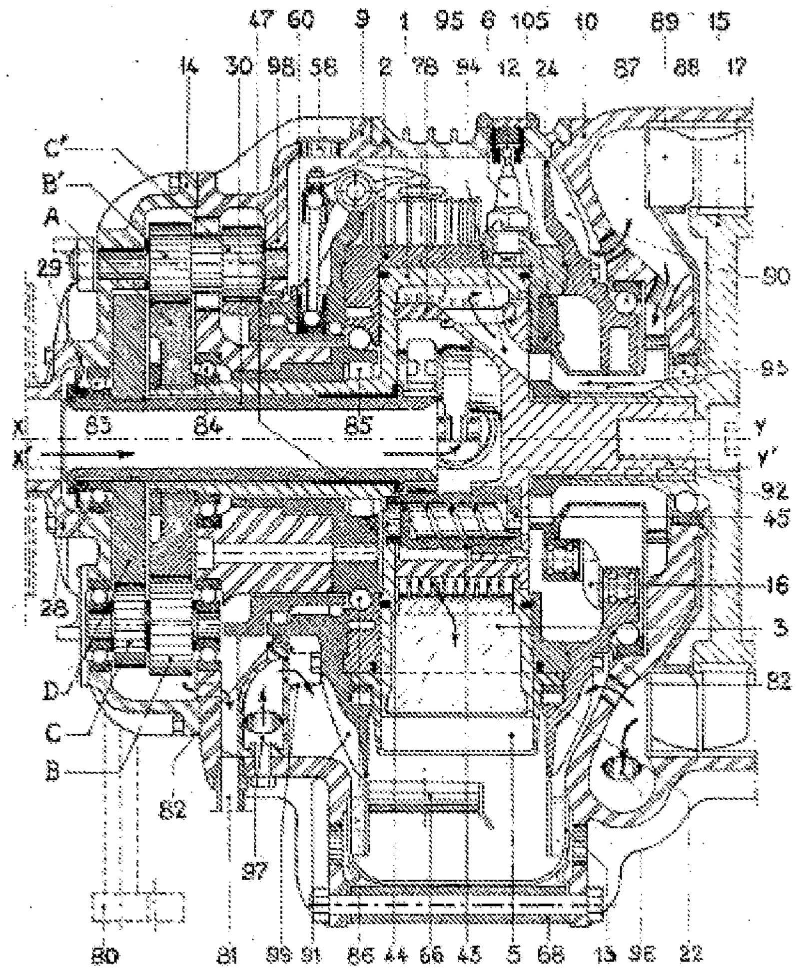
FIG.1



Echelle 0 5 10 15 20 cm

SCALE

[FIG.2]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B'
A
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93
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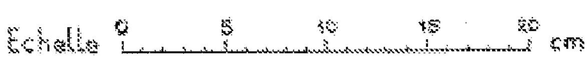
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SCALE

FIG.3

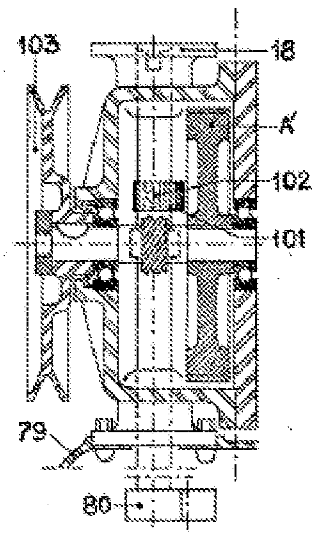


FIG.4

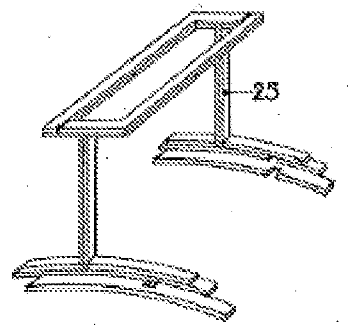


FIG.5

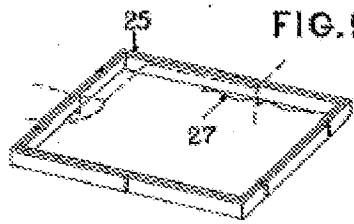


FIG.6

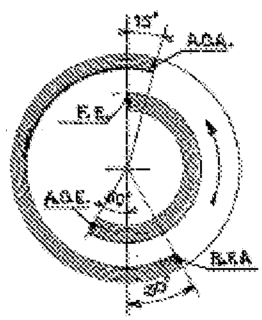


FIG.7

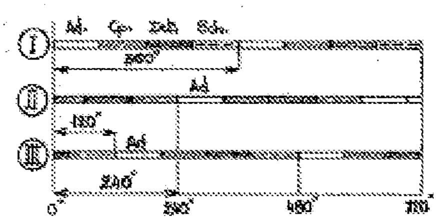


FIG.8

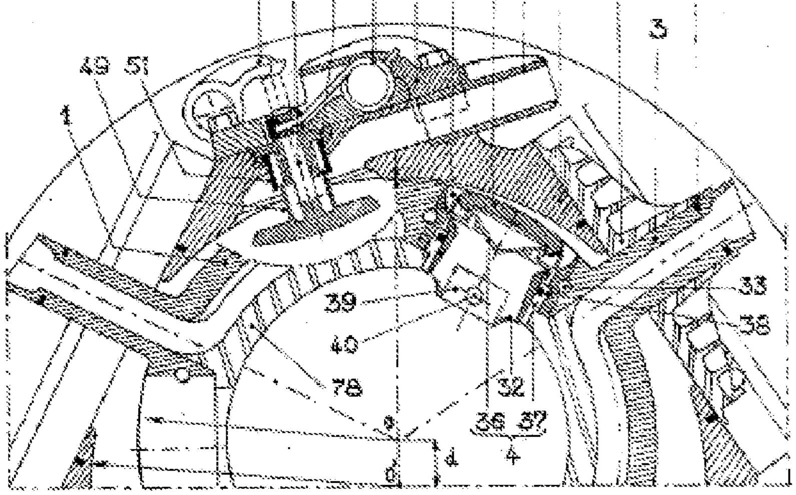


FIG.10

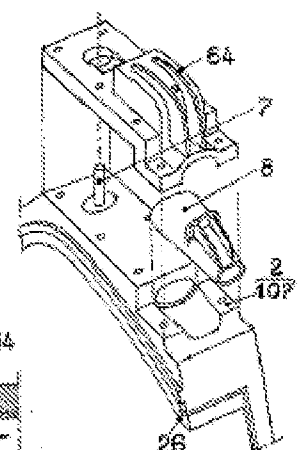


FIG. 9

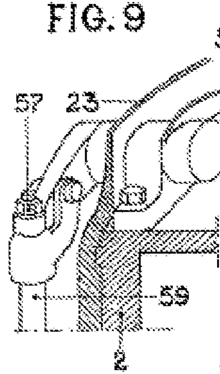


FIG.11

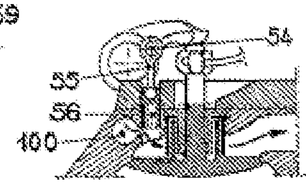


FIG.12

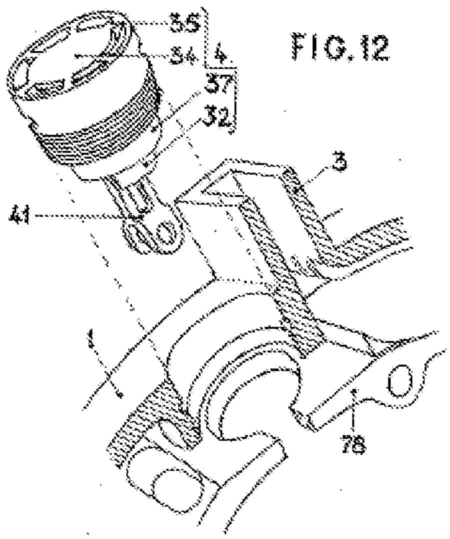


FIG.13

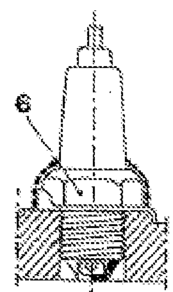


FIG.14

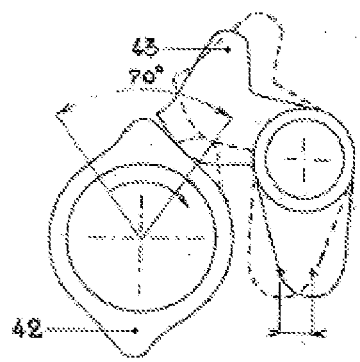


FIG.15

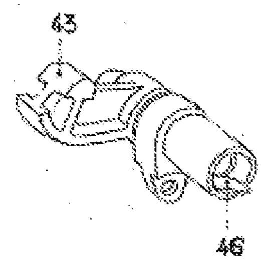


FIG.16

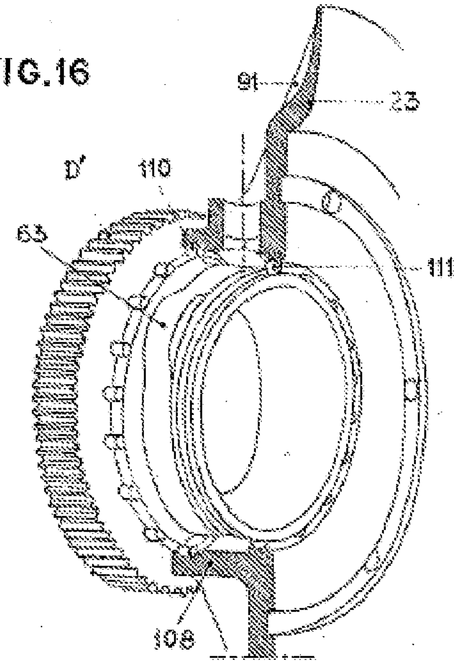


FIG.17

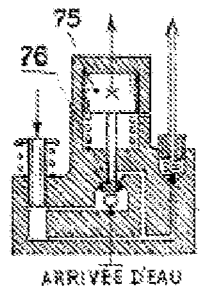
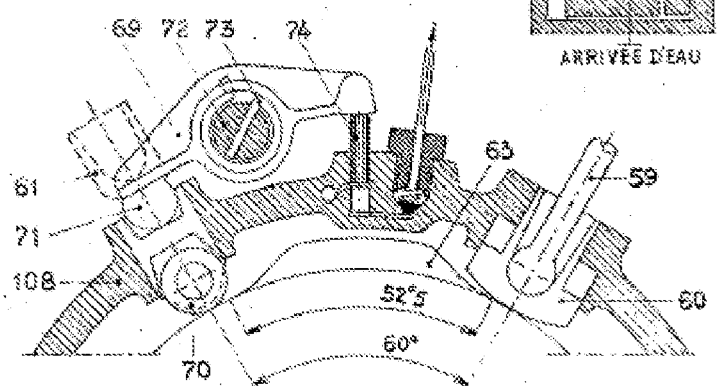


FIG.18



[Key to Fig. 17: 1. Water intake]

FIG.19

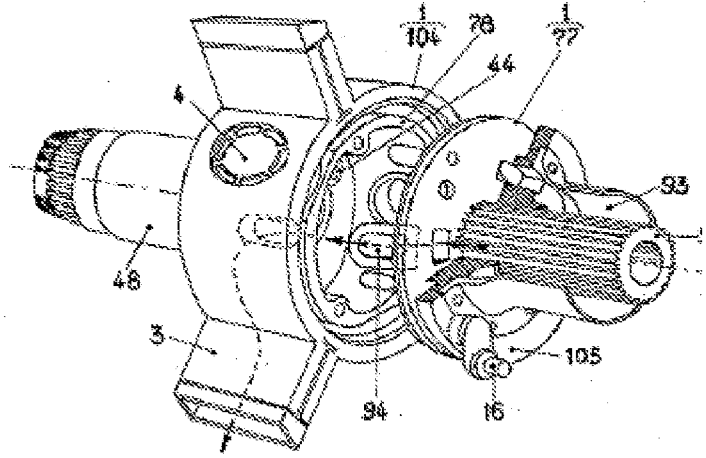

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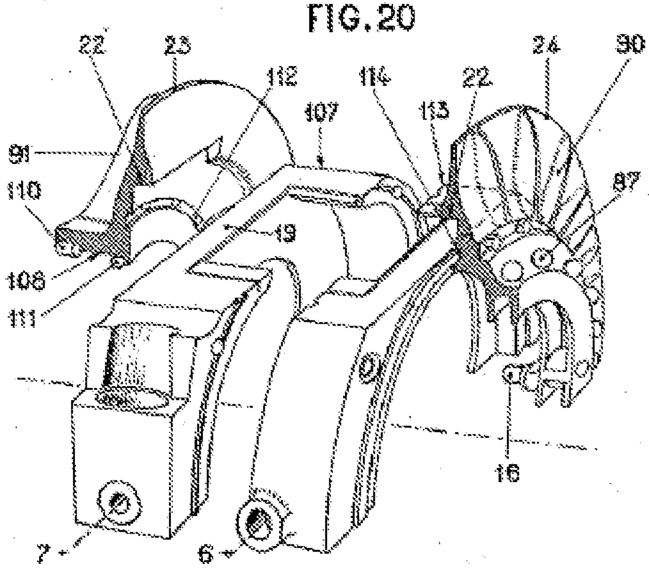
FIG.20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16
7
6

FIG. 21

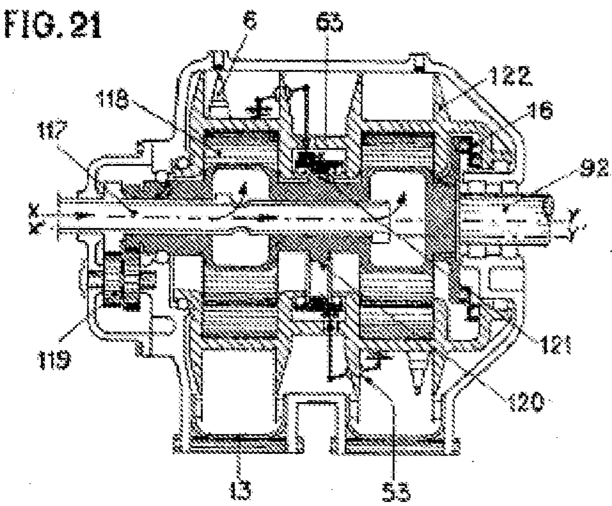
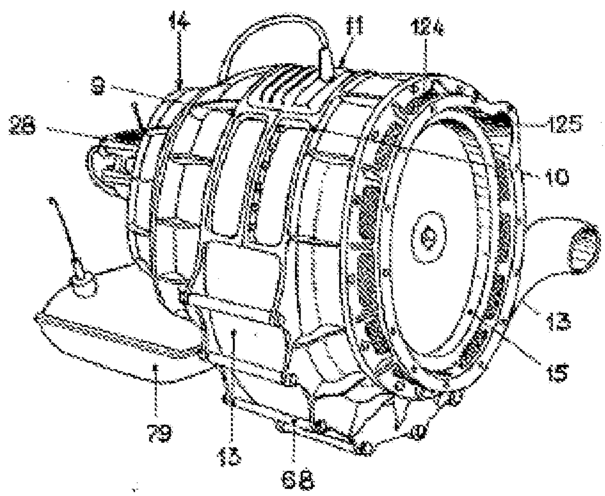

6
63
122
118
16
117
92
X
X'
Y
Y'
119
121
120
13
53

FIG.22


14
11
124
9
125
28
10
13
15
79
13
68